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Indian Standard

MINE HAULAGE TRACKS — SWITCHES AND CROSSINGS — GENERAL REQUIREMENTS

UDC 622·152·8

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BUREAU OF INDIAN STANDARDS
MANAK BHAVAN, 9 BAHADUR SHAH ZAFAR MARG
NEW DELHI 110002

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Mine Transportation Sectional Committee, HMD 8

FOREWORD

This Indian Standard was adopted by the Bureau of Indian Standards, after the draft finalized by the Mine Transportation Sectional Committee had been approved by the Heavy Mechanical Engineering Division Council.

Switches and crossings in underground mines are considered important not only from performance but from safety point of view also. Improperly designed and installed switches and crossings may lead to reduced output and increased accidents.

This Indian Standard which gives the general requirements of switches and crossings for use in underground mines is expected to rationalise the practices followed and provide a uniform practice.

The details and requirements of Statutory Bodies, or specified otherwise, shall be followed by those concerned about such switches and crossings.

For the purpose of deciding whether a particular requirement of this standard is complied with, the final value, observed or calculated, expressing the result of a test or analysis, shall be rounded off in accordance with IS 2 : 1960 'Rules for rounding off numerical values (*revised*)'. The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.

Indian Standard

MINE HAULAGE TRACKS — SWITCHES AND CROSSINGS — GENERAL REQUIREMENTS

1 SCOPE

This standard specifies the general requirements of switches and crossings of mine haulage tracks for use in underground mines.

2 REFERENCES

The Indian Standard IS 3964 : 1980 'Light rails (*first revision*)' is a necessary adjunct to this standard.

3 TERMINOLOGY

For the purpose of this standard the following definitions shall apply.

3.1 Flangeway

It is the gap between following three pairs of rails through which wheel flange passes:

a) Tongue and stock rails of a switch in open position;

b) Running rails and check rails in crossing portion; and

c) Wing rails and vee rails in crossing portion.

In underground mine haulage tracks, it amounts to 35 mm plus gauge widening, if any.

3.2 Heel of a Switch

The point at which standard flangeway is obtained.

3.3 Switch Heel Divergence

It is the distance between gauge lines of stock rail and tongue rails at the heel. It is equal to the clearance between these two rails at heel plus the width of tongue rail head.

3.4 Plan Length of a Switch

This is equal to:

$$\frac{\text{Rail Head Width} \times \text{Switch Length}}{\text{Switch Heel Divergence}}$$

3.5 Switch Angle

The angle having a tangent equal to:

$$\frac{\text{Switch Heel Divergence}}{\text{Switch Length}}$$

3.6 Switch Throw

The distance moved by the point or toe of the switch from one extreme position to the other.

3.7 Crossing Angle

The angle between the running edges of the two rails making up the 'Vee' of the crossing.

3.7.1 On a plan of the tracks the angle between the tangents to the two tracks at their point of intersection is equal to the crossing angle.

3.7.2 From Fig. 1A, it shall be clear that the unit angle is the ratio of A to B, where A is the length of bi-sector between this line and the intersection of the legs; and B is the distance between the legs of the angle at any point measured along a line at right angles to the bi-sector.

$$\text{Thus, unit angle} = \frac{A}{B}, \text{ angle is 1 in } \frac{A}{B}$$

3.8 Crossing Nose

The point of inter-section of the gauge lines of the two rails making up the crossing 'Vee', forms the theoretical nose of crossing.

3.8.1 The actual nose of the crossing shall not run to a fine point but usually remains 10 mm thick but not less than the web thickness of rail. Thus, the actual nose is this thickness multiplied by crossing angle behind theoretical nose of the crossing as shown in Fig. 2.

3.9 Lead

The distance from the toe or point of a switch to a point opposite the crossing nose measured along a straight line tangential to the main track at the switch heel.

3.10 Facing Turnout

Facing turnout is that in which the train passes first over a switch and then over the crossing.

3.11 Trailing Turnout

It is reverse of facing turnout. In this, the train passes first over a crossing and then over the switch.

4 NOMENCLATURE

The nomenclature of the various parts of a turnout shall be as given in Fig. 2.

5 DIMENSIONS AND CONSTRUCTIONAL DETAILS

5.1 Recommended dimensions of turnouts off straight track for ISLR 25 and ISLR 30 of gauge 610 mm are given in Table 1.

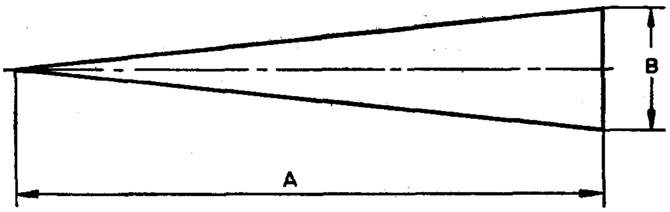
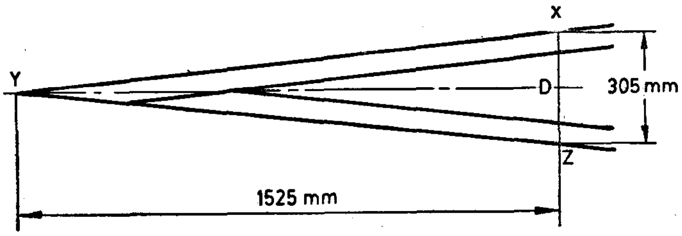


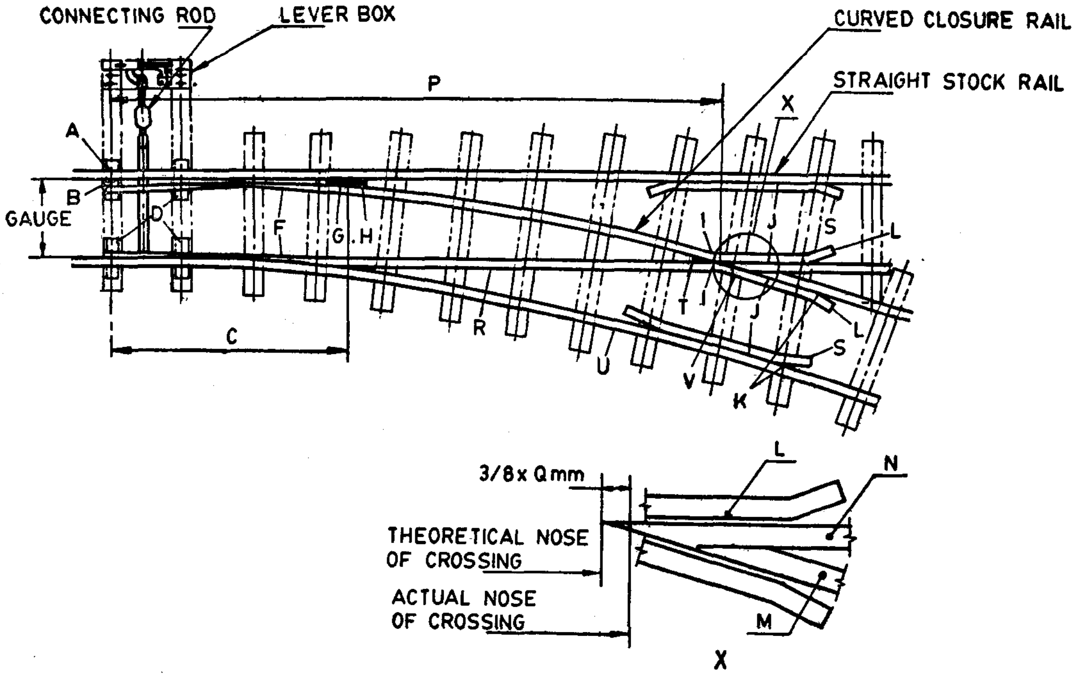
FIG. 1A METHODS OF MEASUREMENT OF CROSSING ANGLE MEASUREMENT ON THE UNIT SYSTEM



For example, in Fig. 1B;
$A = Y\ D = 1\ 525$ mm; and
$B = Z\ X = 305$ mm;

Therefore the angle is 1 in $\frac{1\ 525}{305}$ or 1 in 5.

FIG. 1B EXPLANATION FOR UNIT ANGLE



A = Toe of switch
B = Switch throw
C = Length of switch
D = Slide plates
E = Stretcher rod
F = Switch blades
G = Heel of switch

H = Heel of block
I = Knuckle of crossing
J = Flangeway
K = Check block
L = Wing rail
M = Splice rail
N = Point rail

P = Lead of turnout
Q = Angle of crossing (1 IN Q)
R = Straight closure rail
S = Check rail
T = Knuckle block
U = Curved stock rail
V = Nose block

FIG. 2 NOMENCLATURE OF VARIOUS PARTS OF TURNOUT

5.2 Constructional Details

5.2.1 *Switch Blade*

The length of switch blade shall be greater than the longest wheel base, which shall pass over it under normal operating conditions, otherwise there shall be a tendency for the point to kick open (away from the stock rail) as the vehicle passes, possibly causing a derailment.

Table 1 Dimensions of Turnouts Off Straight Track for ISLR 25* and ISLR 30 Rails and Gauge 610 mm

(*Clause* 5.1)

Crossing Angle	Length of Straight Infront of Theoretical Nose	Distant Apart of Gauge Lines at Distance in Front of Nose	Switch Details			Lead	Curved Closure Rail		Length of Straight Closure Rail
			Length	Angle	Heel Spread		Radius	Off-set	
degree	mm	mm	m	degree	mm	m	m	mm	m
Y	*S*	*t*	*d*	*X*	*L*	*DA*	*R*	*W*	
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
2·00	152	76	0·914	10	92	2·565	3·658	75	1·143
2·25	171	76	0·914	10	92	2·731	4·724	70	1·308
2·50	191	76	0·914	10	92	2·896	5·943	65	1·473
2·75	210	76	0·914	10	92	3·061	7·239	63	1·587
3·00	229	76	1·829	20	92	4·394	8·154	83	1·969
3·25	248	76	1·829	20	92	4·585	9·601	79	2·127
3·50	267	76	1·829	20	92	4·763	11·125	78	2·286
3·75	286	76	1·829	20	92	4·941	12·802	76	2·444
4·00	305	76	1·829	20	92	5·118	14·782	73	2·604
4·25	324	76	1·829	20	92	5·296	16·764	72	2·763
4·50	343	76	1·829	20	92	5·461	18·898	70	2·909
4·75	362	76	1·829	20	92	5·626	21·156	68	3·055
5·00	381	76	1·829	20	92	5·791	23·622	67	3·201
5·50	419	76	1·829	20	92	6·109	28·956	64	3·442
6·00	457	76	1·829	20	92	6·426	35·052	60	3·683
6·00	457	76	2·743	30	92	7·671	33·223	75	4·013
6·50	496	76	1·829	20	92	6·731	41·758	57	3·987
6·50	496	76	2·743	30	92	8·027	39·319	70	4·369
7·00	534	76	1·829	20	92	7·010	49·378	52	4·267
7·00	534	76	2·743	30	92	8·356	45·720	70	4·698
7·50	572	76	2·743	30	92	8·699	53·036	67	5·042
8·00	610	76	2·743	30	92	9·017	60·960	64	5·360
8·50	648	76	2·743	30	92	9·322	69·494	62	5·511
9·00	686	76	2·743	30	92	9·640	78·639	60	5·829
9·00	686	76	3·658	40	92	10·935	75·590	70	6·210
9·50	724	76	3·658	40	92	11·252	84·735	68	6·375
10·00	762	76	3·658	40	92	11·607	94·183	60	6·731

*For details of ISLR 25 and ISLR 30 rails, refer to IS 3964 : 1980.

5.2.2 *Crossing Vee or Frog*

It is generally recommended that crossing vee or frogs shall be built up from rails.

5.2.3 *Closure Rails*

In a turnout off straight track there shall be two closure rails, one straight and one curved as shown in Fig. 2.

5.2.4 *Lever Boxes*

There shall be mainly three types of lever boxes used with mine track:

a) Weight assisted type;

b) Flush fitting floor type (generally used where space is limited); and

c) Spring lever box type. In this type, an over centre spring presses the switch blade which is currently in use against the appropriate stock rail.

5.2.4.1 *Operational note*

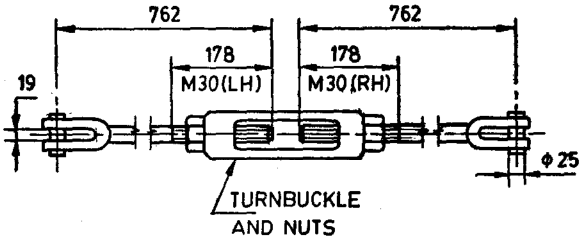
The movement of the switch blade is liable to be impeded by small stones, so personnels who operate turn-outs shall always be instructed to check that the required blades have gone home snugly against the appropriate stock rail.

5.2.4.2 It is desirable that on more important turnout, particularly facing turnouts on tracks used for main coal/material haulage or man riding, detection of full level of blades by means of FLP limit switches and indication lights be provided.

5.2.4.3 It shall be noted that an incorrectly set trailing turn-out, seldom causes derailment, but facing turnouts set for the wrong road or stuck half way, shall frequently be the cause of accidents.

5.2.5 *Connecting Rods*

Connecting rods shall be made between the lever box and the switch blades complete with a turn buckle for adjustment, as shown in Fig. 3. This shall restrict movement of lever boxes on timbers to obtain adjustment of the switch movement.



All dimensions in millimetres.

FIG. 3 SWITCH CONNECTING ROD INCORPORATING A TURNBUCKLE

5.2.6 *Stretcher Rods*

Stretcher rods shall be used to connect the two switch blades of a turnout and maintain these blades in their correct position, relative to one another.

5.2.6.1 The stretch rod shall be a simple flat bar fastened to the base of the rail. Fig. 4 indicates two types of stretcher rods.

6 TYPES OF LAYOUT

6.1 Cross Over Roads from a Straight to a Parallel Straight Track

The cross-over consists of two turnouts connected together by a length of straight track as shown in Fig. 5. Formula for calculation of length of straight is given below:

Let, A = lead between theoretical noses of the two crossings measured parallel to the main lines,

A_x = lead between the actual noses of the two crossings measured parallel to the main lines,

B = distance between the theoretical crossing noses measured along the centre of the diagonal track,

Q = unit angle of the two crossings,

L = space between the gauge lines of the two parallel tracks,

M = gauge, and

P_x = lead from toe to switch to actual nose of crossing.

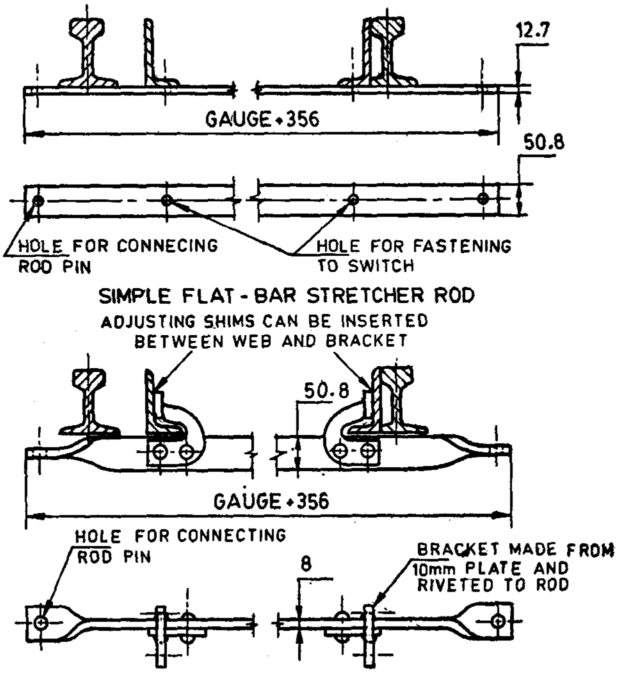
Then:

$$A = Q(L - M) - \frac{L + M}{4Q}$$

$$A_x = A - 2Q$$

$$B = Q(L - M) + \frac{L + M}{4Q}$$

The overall length from switch toe to switch toe measured parallel to the main lines = $2P_x + A_x$


12.7
GAUGE+356
50.8
HOLE FOR CONNECING ROD PIN
HOLE FOR FASTENING TO SWITCH
SIMPLE FLAT-BAR STRETCHER ROD
ADJUSTING SHIMS CAN BE INSERTED BETWEEN WEB AND BRACKET
50.8
GAUGE+356
HOLE FOR CONNECTING ROD PIN
8
BRACKET MADE FROM 10mm PLATE AND RIVETED TO ROD

All dimensions in millimetres.

FIG. 4 STRETCHER ROD WITH BRACKETS

6.2 An illustration of simple turnout off a straight main track is given in Fig. 6. Formula for calculation of this turnout off a straight main line is given below:

Let,

B = guage,

L = switch heel divergence,

D = lead from heel of switch to theoretical nose of crossing,

D_A = lead from toe of switch to actual nose of crossing,

d = switch length,

s = straight length infront of theoretical crossing nose,

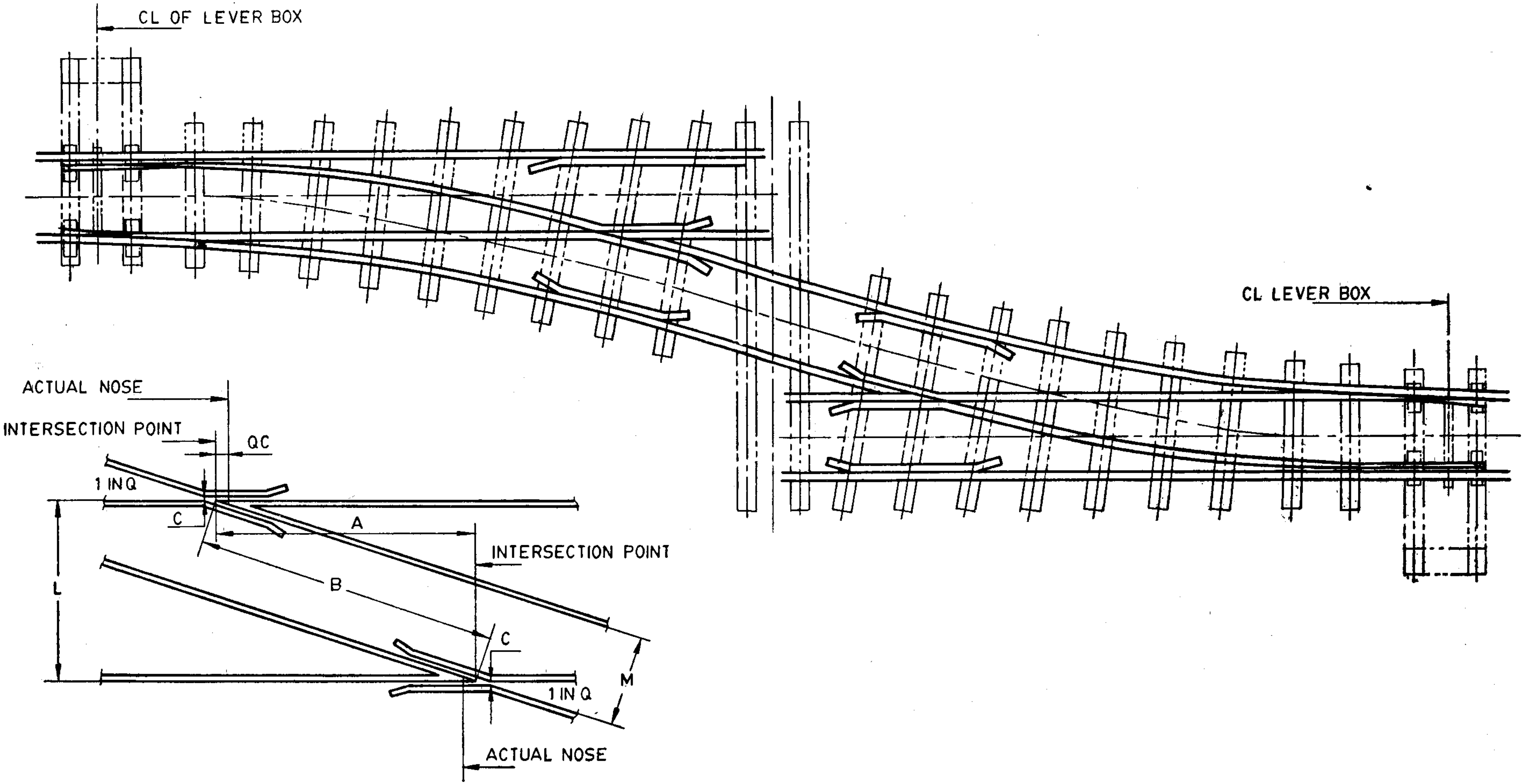


FIG. 5 A TYPICAL CROSSOVER WITH DIAGRAM SHOWING SYMBOLS USED IN CALCULATIONS

t = distance between gauge lines at distance 'S' from theoretical nose of crossing,

v = thickness of crossing nose,

R = radius of curved closure rails,

W = offset from the curved closure rail to the midpoint of the chord joining the switch heel to a point at distance 'S' infront of crossing nose,

X = unit angle of switch, and

Y = unit angle of crossing.

With the exception of X and Y which are numbers, all the above items shall be taken in the same units.

Then:

$$D = \frac{2X(B-L-t)}{X+Y} + Yt$$

$$D_A = D + L + Yv$$

$$R = \frac{2X^2Y^2(B-L-t)}{X^2-Y^2}$$

$$W = \frac{X-Y}{X+Y} \times \frac{(B-L-t)}{4}$$

6.3 Turnouts Off Curved Main Lines

In some cases it shall be necessary to have turnouts off curved main lines. In these instances, it may be assumed (although it may not be mathematically correct) that the lead of a turnout off a curve shall be the same as that of a turnout off the straight, provided that the same type of switches and the same crossing angles are used. The radius of turnout curve shall be different in each of the two cases.

7 DESIGN OF TURNOUTS

7.1 If the radii of the main track and the turnout curve are known, it is possible to calculate the equivalent radius of the turnout, if the main track was straight.

7.1.1 From the lead, crossing angle and type of switch may be obtained and hence, the complete turnout may be designed.

7.1.2 Illustration for the conversion to an equivalent radius turnout off straight track of a turnout off curved track of similar flexure (left) and a turnout off a curve of contra-flexure (right) is given in Fig. 7 and formula for calculation is given below;

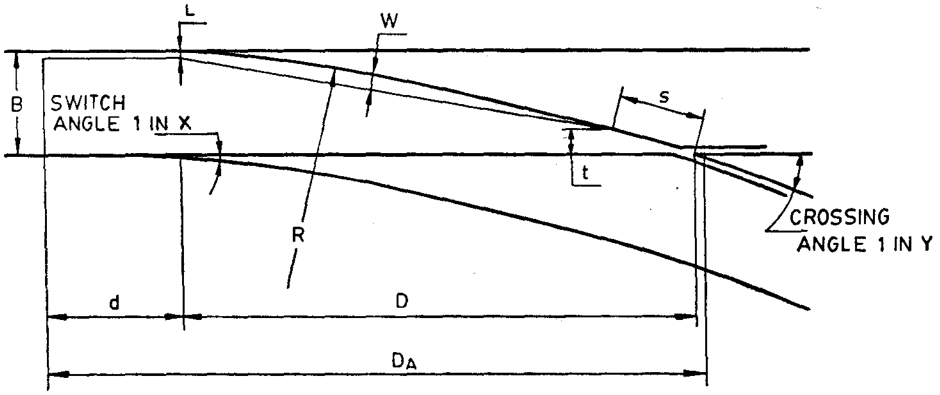


FIG. 6 KEY DIAGRAM OF TURNOUT OFF A STRAIGHT TRACK, SHOWING SYMBOLS USED IN TABLE AND CALCULATIONS

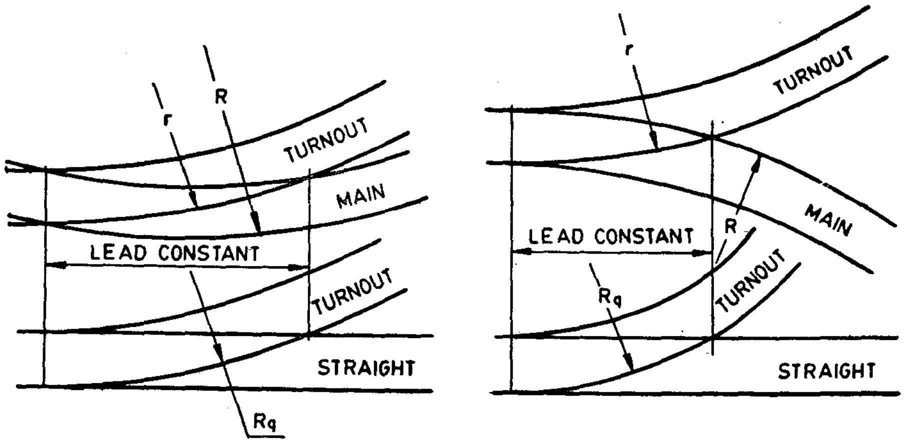
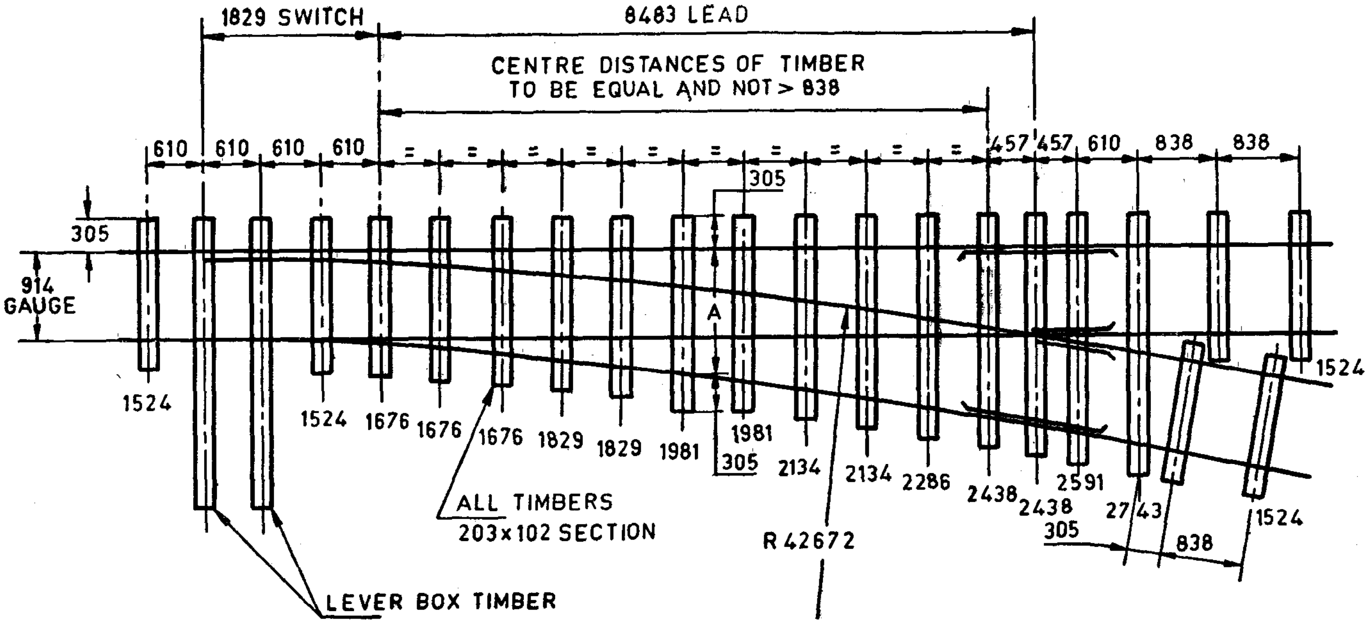


FIG. 7 ILLUSTRATING THE CONVERSION TO AN EQUIVALENT RADIUS TURNOUT OFF A CURVED TRACK OF SIMILAR FLEXURE (LEFT), AND A TURNOUT OFF A CURVE OF CONTRA-FLEXURE (RIGHT)



All dimensions in millimetres.

FIG. 8 STANDARD ARRANGEMENT OF TIMBERS FOR 915 mm GAUGE 1 IN 5 TURNOUT OFF STRAIGHT TRACK

Let,

R = radius of the curved main line;

r = radius of the turnout curve; and

R_q = equivalent radius of the turnout in a straight main line.

Turnout and main line curves of similar flexure with $r < R$

$$R_q = \frac{R \times r}{R - r}$$

Turnout and main line curves of similar flexure with

$$R_q = \frac{R \times r}{r - R}$$

Turnout and main line curves of opposite flexure $R_q = \frac{R \times r}{R + r}$

8 TIMBERING OF CROSSING WORK

8.1 Placement of Timbers (Sleepers)

Timbers (sleepers) shall be put directly under the crossing nose and one close on each side of it as shown in Fig. 8.

8.2 Size of Timber

8.2.1 *Cross-section*

Sleepers or timbers used for the support of crossing work shall be of the same cross-section as the sleepers used on plain track.

8.2.2 *Length*

Lengths of the timber shall be equal to the distance between the outside gauge lines of the four rails plus 600 mm.

8.2.3 The lever box shall be carried on two long timbers. The length and centre distance of these timbers shall be suitable for the type of lever box to be used.

8.3 The intermediate timbers between the switch heel and the crossing shall be set out at equal intervals but not exceeding 800 mm.

9 SPRING CONTROLLED SWITCHES

9.1 The switch blades shall normally be held for traffic in one direction, but any vehicle, approaching from the side track may move the blades over against the spring and so pass on to the main tracks.

9.1.1 Spring controlled switches are commonly used for a drop back and an illustration of such a switch is given in Fig. 9.

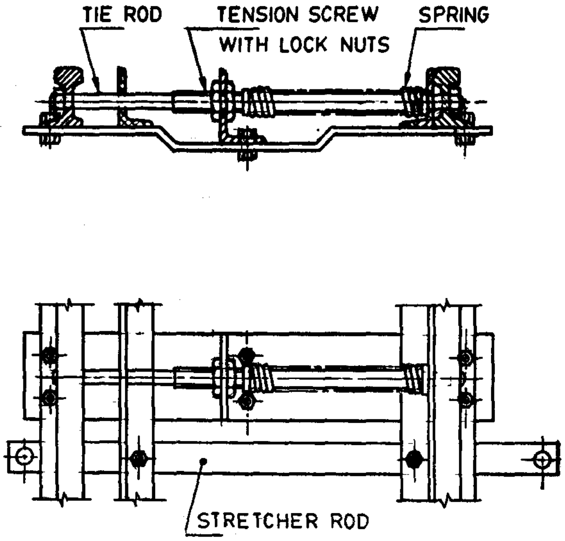


FIG. 9 SPRING CONTROLLED SWITCH

9.2 On sleeper inclines, where all traffic normally moves upward, it is advisable to use a spring controlled switch as a catch point to derail and turn into the road side, any runaway vehicles coming back down the incline.

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